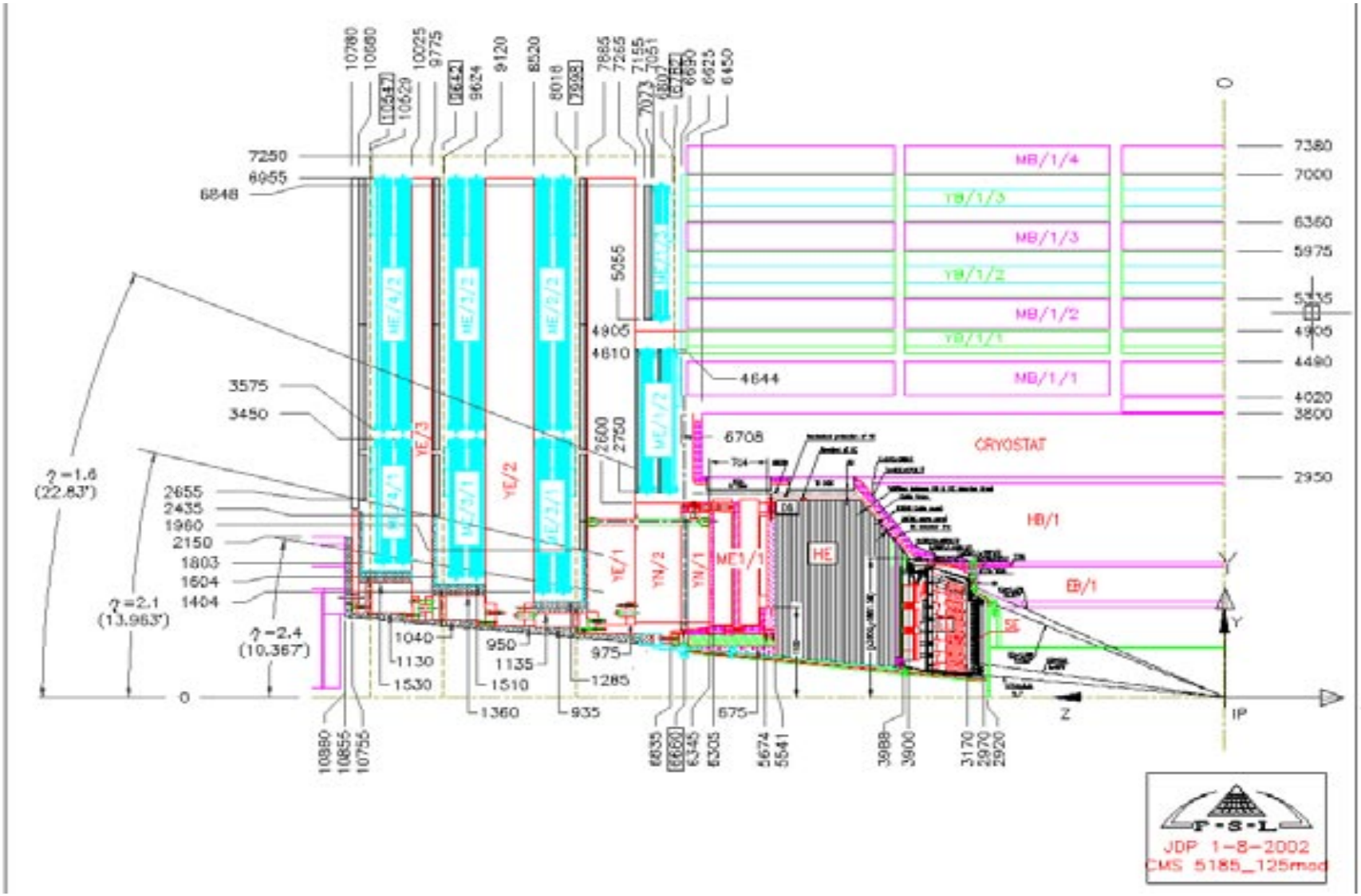
Endcap Muon System

Dick Loveless

DOE/NSF Review

19-21 May 2003

Endcap Muon System



EMU developments

- **New L2 managers:**
  - Dick Loveless for Project
  - Mike Lindgren/Giorgio Apollinari for M&O
- **Continued good progress on chamber and electronics production**
- **FAST sites (UCLA, Florida, PNPI, IHEP) are operational, good flow of chambers to CERN**
- **CERN ISR facility receiving, testing chambers; passed internal review in Mar '03**
- **Endcap infrastructure being installed (walkways, gas piping, corner pieces, mounting posts, cable trays, etc.)**
- **Partial upscope for ME4/1 (151K$)**
  - Allows us to complete electronics assembly and testing
  - Still need cables and off-chamber electronics (~760K$)

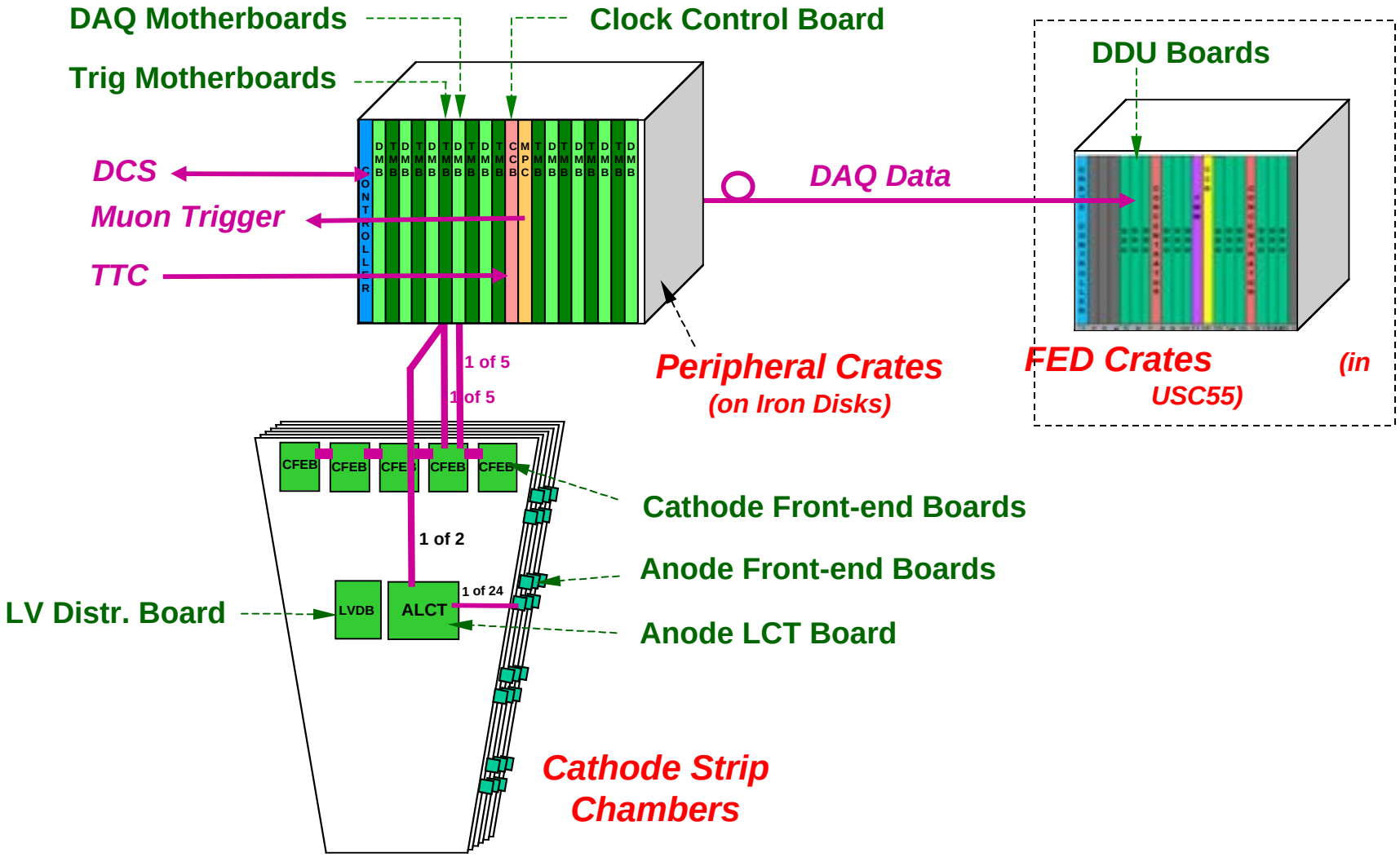
chamber production

Chamber assembly and testing (HV & leak)

- Panel factory (Fermilab) finished
- ME23/2 (Fermilab) 150/150 finished
- ME2/1 (Russia) 36/38 finished
- ME3/1 (Russia) 25/38 finished
- ME4/1 Russia) 0/38 finished (recently upscoped)
- ME1/2 (China) 71/74 finished
- ME1/3 (China) 36/74 finished

Req'd chambers = 312/396 = 79% finished

EMU Electronics System



Electronics production

On-chamber electronics

- CFEB (cathode FE - Ohio State) 2186/2500 rec'd
- AFEB (anode FE - CMU) 12,146/12,146 finished
- ALCT-672 (ME23/1 - UCLA) 85/85 rec'd
  - ALCT-672 (ME4/1) ordered 35 more
- ALCT-384 (ME23/2, ME1/2 - UCLA) 250/250 rec'd
- ALCT-288 ME1/3, ME1/1 - UCLA) 165/165 rec'd
- LVDB (LV distribution - Wisc) 375/505 rec'd
- LVMB (LV monitoring - UC Davis) 400/400 rec'd

Off-chamber electronics

- Waiting for final approval at 25ns test beam

Cable production

- All cables MUST be halogen-free
- All cables MUST be approved by CERN
- Cable lengths calculated using the 3D CAD model

On-chamber cables

• CFEB cables	finished
• AFEB cables	finished
• LV harness	finished

Off-chamber cables

• Skew-clear cables	6342/6360
• LVMB cables	approved - ordering in progress
• LV input	not yet approved
• HV cables	213/438

Electronics assembly & testing

FAST (Final ASsembly & Testing) sites

- **Florida (ME23/2)** **41/75 finished**
- **UCLA (ME23/2)** **49/75 finished**
- **PNPI (ME234/1)** **8/114 finished**
- **IHEP (ME1/2, ME1/3)** **4/144 finished**
- **All FAST sites now operational**
  - Discovered & fixed electronics problems
  - Modified chamber hardware (grounds, screws)

CERN ISR testing site

- **75 chambers delivered from FAST sites**
- **45 chambers ready for installation**

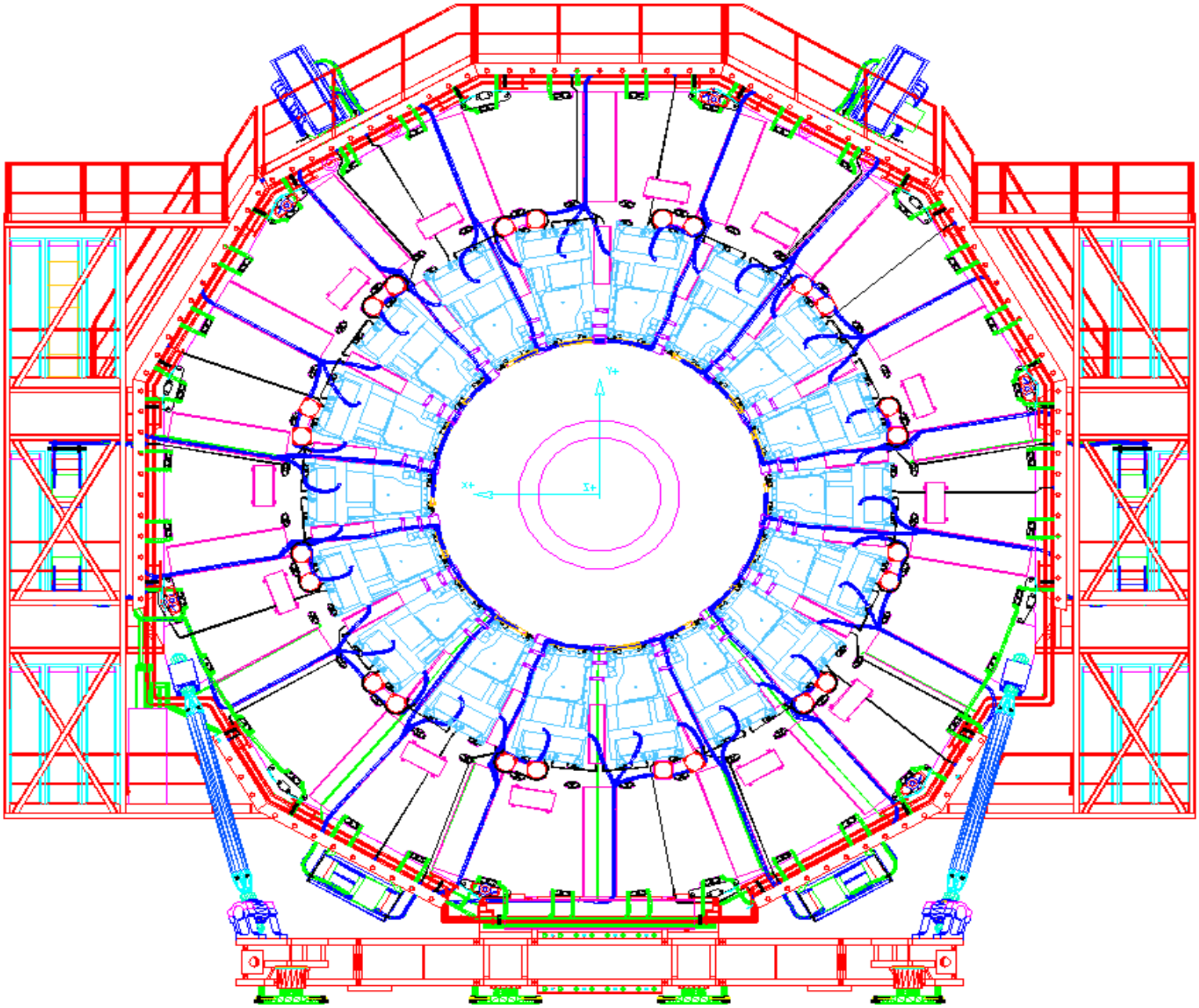
ISR chamber testing site

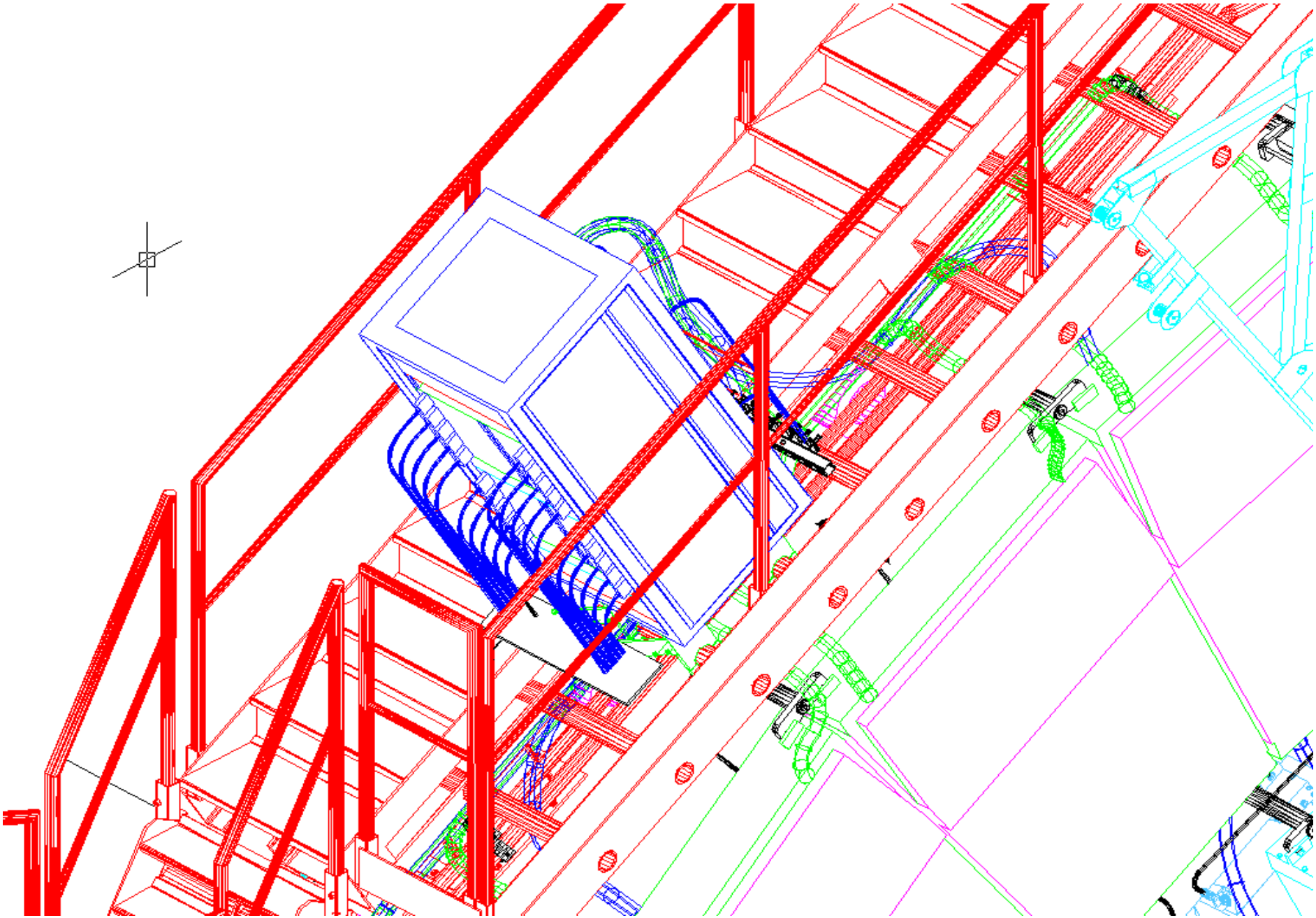
Endcap integration

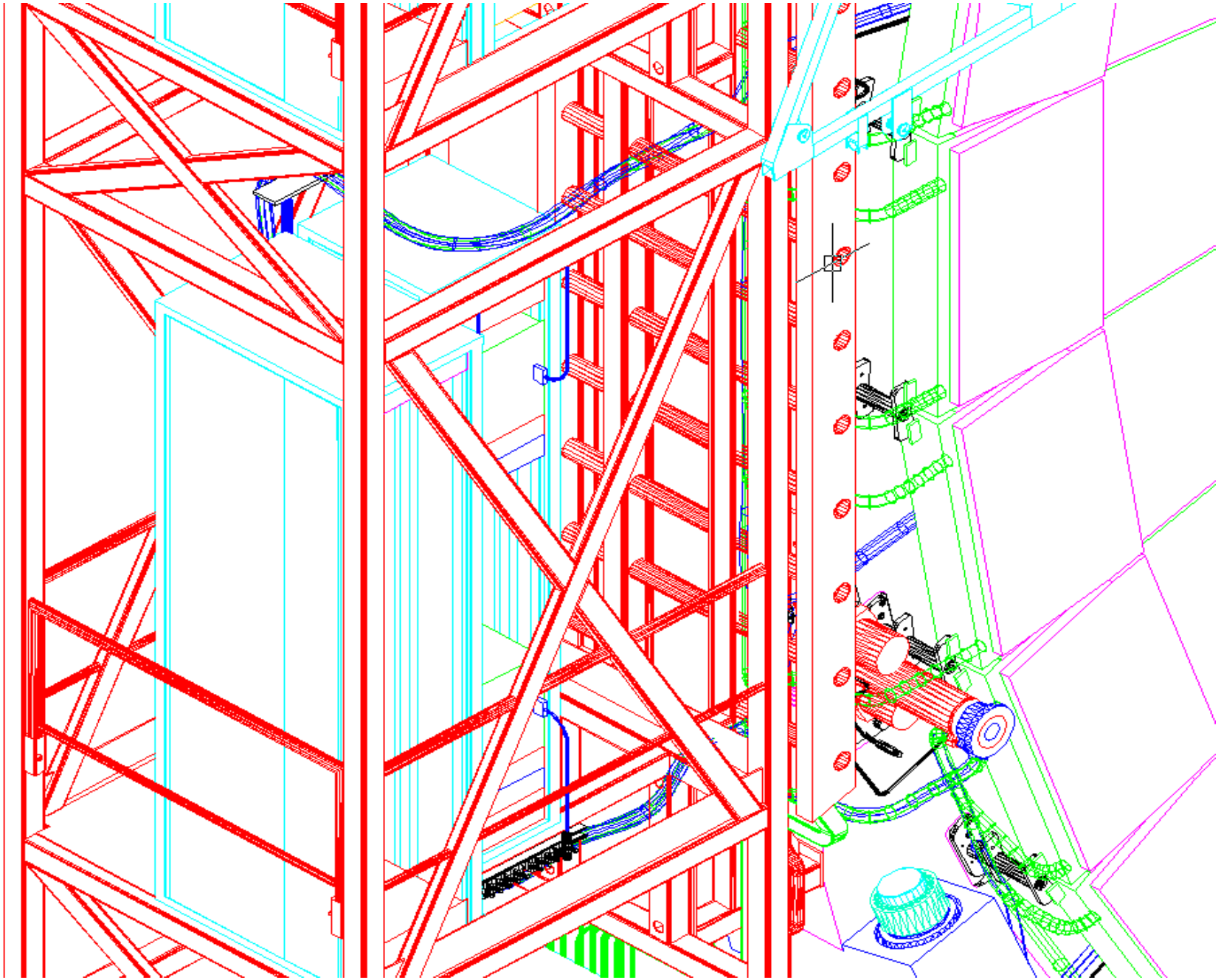
Coherent design of all infrastructure by EMU

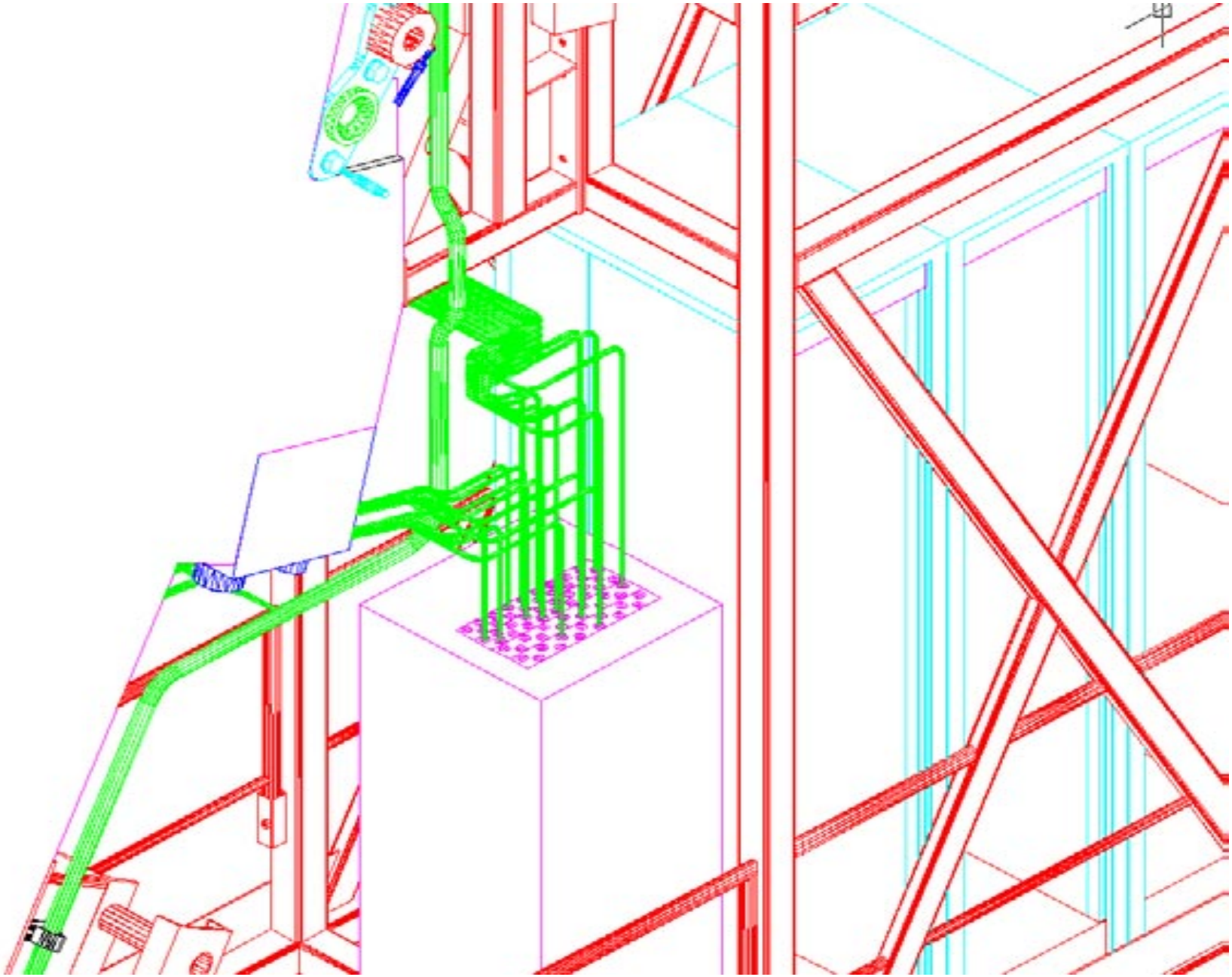
- **Endcap disks (built by Kawasaki and Hudong)**
- **Corner posts (built by Serbia as contribution)**
- **Peripheral skeleton (built in Great Britain)**
  - Contains off-chamber electronics
  - Provides possible access to services
- **Alignment (in production)**
- **Shielding (built in Germany)**
- **Gas piping (contract with Polish company)**
- **Cable trays (contract with French company)**
- **Water cooling (in production at Wisconsin)**
- **Chamber mounting (built by Wisconsin)**
  - Design so services do not impede chamber removal for maintenance
- **Magnetic sensors (design by Fermilab)**

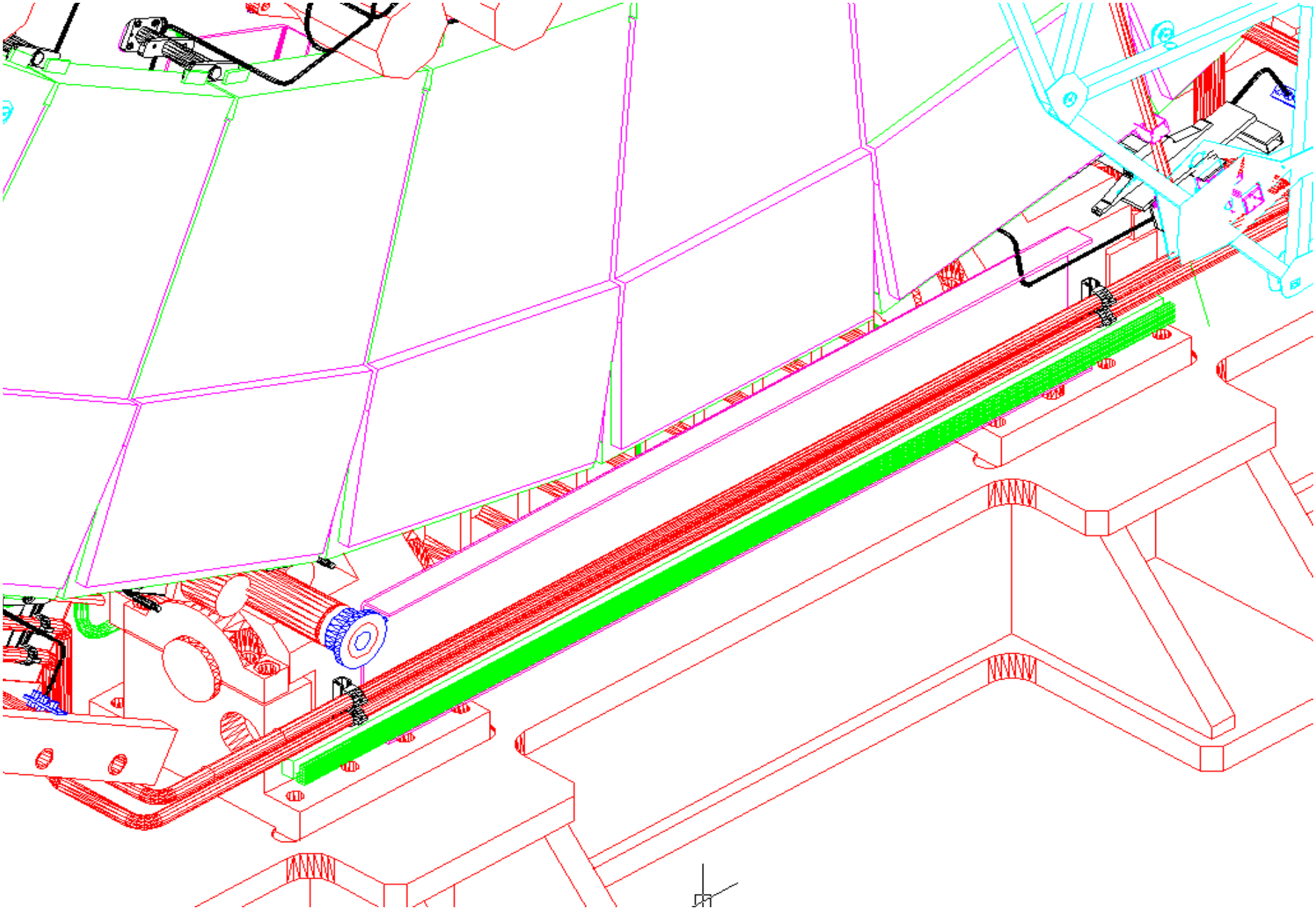
Use 3D CAD system!!

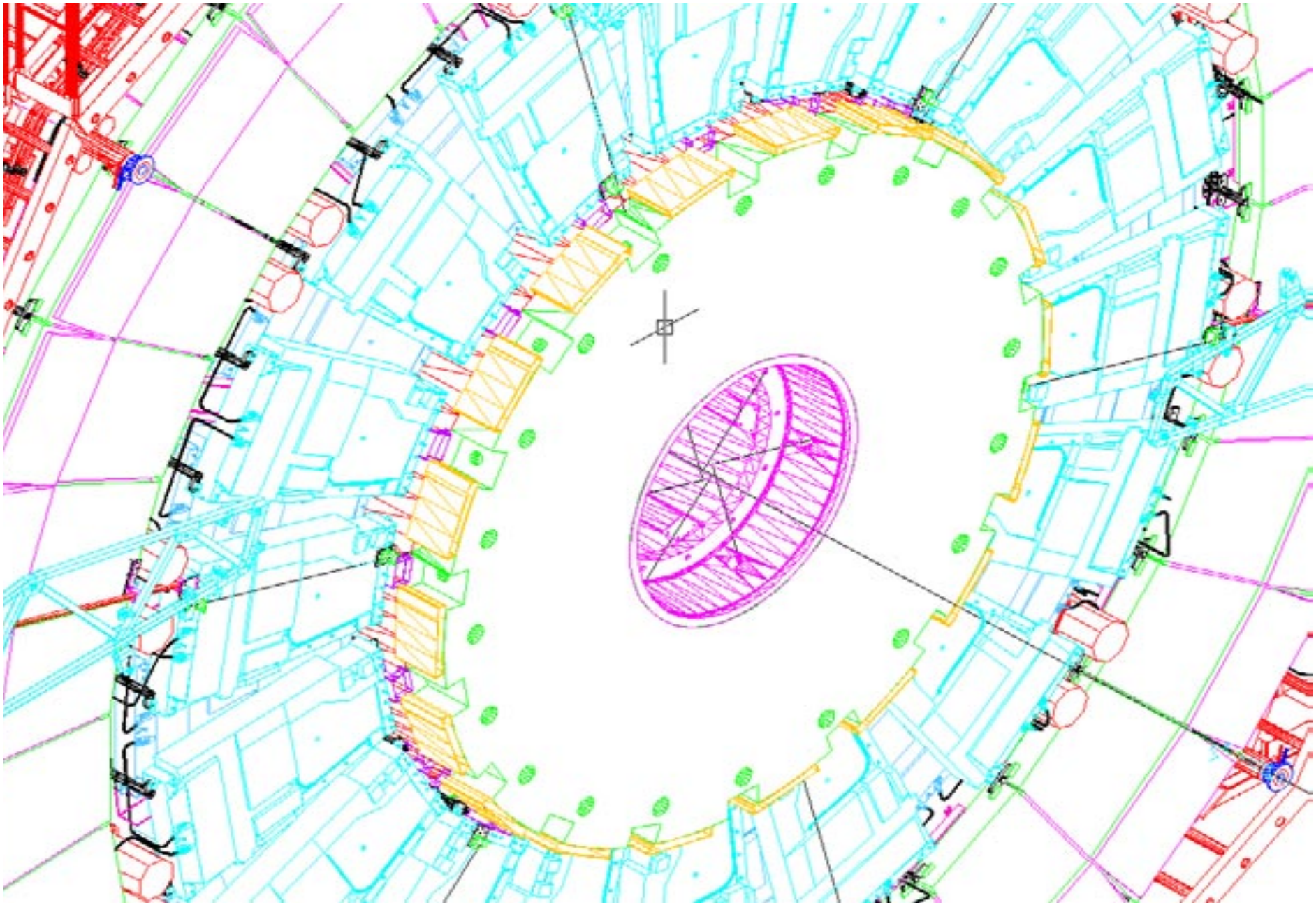








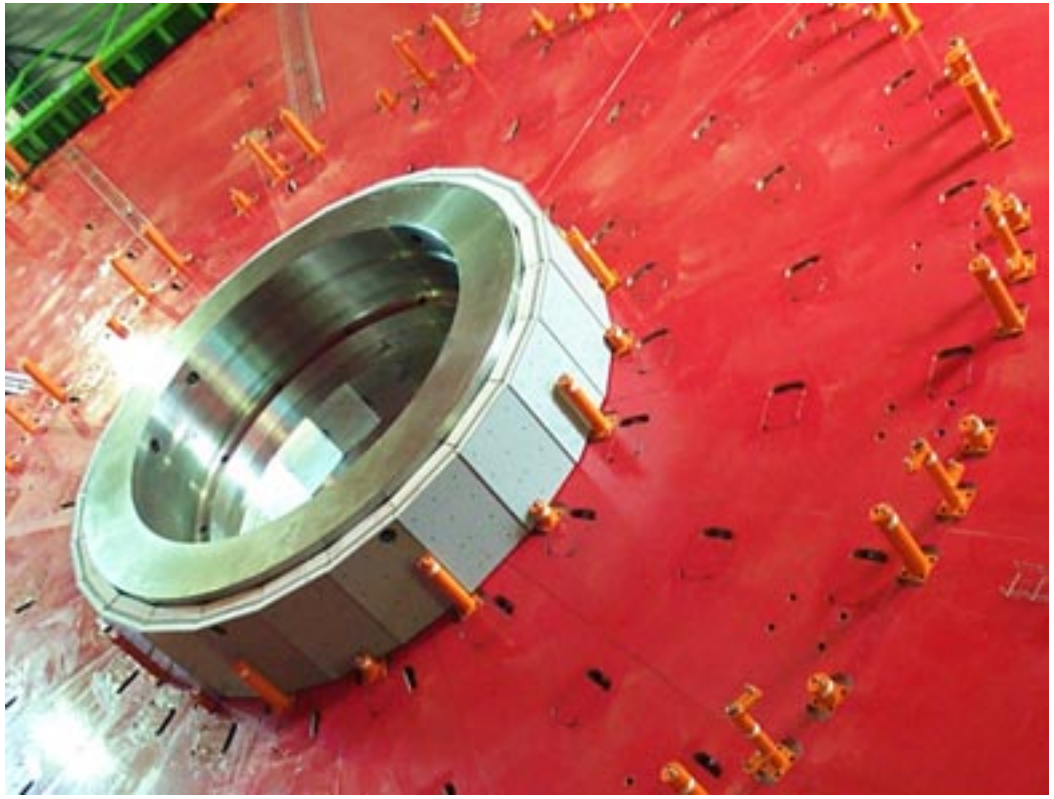




Endcap infrastructure

•Corner piece - showing the two spacers and the hydraulic connection between disks

•12 per disk



•Neutron shielding - sandwich layers of Pb and Boron-poly (located on the spacer rings behind each disk) and on disk faces with RPC chambers

Peripheral skeleton

Gas pipe installation

- Gas piping delayed ~3 months
- Expect gas piping to be finished on YE+2 by end of May '03
- Start on YE-2 in Jul '03

- Polish company connects gas racks to bulkheads on periphery
- Connect short laterals during chamber installation

Installation

- **No adjustment of chambers during installation**
  - **Kinematic mounts**
  - **Need accurate locating holes on disk**
  - **Measured to be good to ~200 microns**
  - **Posts designed to deflect < .5mm**
- **installation fixture built & tested by installing prototype CSC on disk**
  - **Atlas ordered a duplicate for their muon system**
- **Cannot install until gas piping finished -- end of May '03**

CERN Reviews

CERN approval necessary for production

- EDR-01 (Nov '98) CSC production
- EDR-02 (Jun '99) CSC production
- ESR-01 (Sep '00) on-chamber electronics
- EDR-03 (Nov '00) alignment concept
- EDR-05 (Dec '01) YE2 integration
- EDR-06 (Feb '02) alignment mechanics
- LHCC (Sep '02) CMS installation
- EDR-08 (Dec '02) YE1 integration
- LHCC (Sep '03) CMS installation
- ESR (~Oct '03) off-chamber electronics

- **Each review generates action items and recommendations**

Conclusions of EDR-08

1. Conclusions and Recommendations of the Committee for Integration of YE1 Stemming from MUON_EDR-08

The Committee commends the EMU Group for the quality of the integration studies made for the Endcaps in general, and YE1 in particular, using 3D CAD models.

The Committee recommends to:

1. **Endorse the general integration scheme of YE1.**
2. **Invest the necessary resources to finalize the integration of HE, EE and ES in general, including all services.**
3. **To present the source calibration scheme for HE to TIS and neighboring systems.**
4. **Organize urgently a specific review of the RE link board project.**

2. Follow-up review for EMU Integration

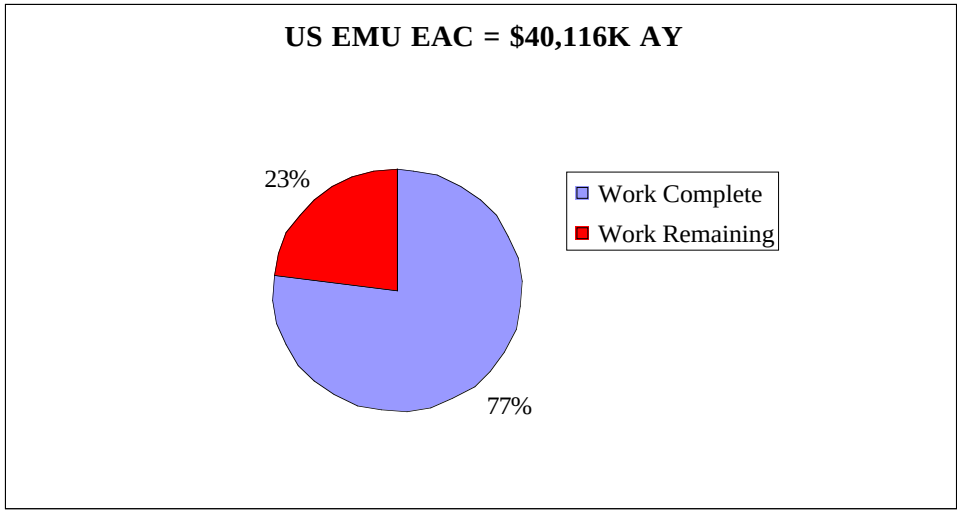
A subsequent review of the progress of YE1 and YE2 integration will be part of the forthcoming EDR to review the integration of YE3, to be held before the end of 2003.

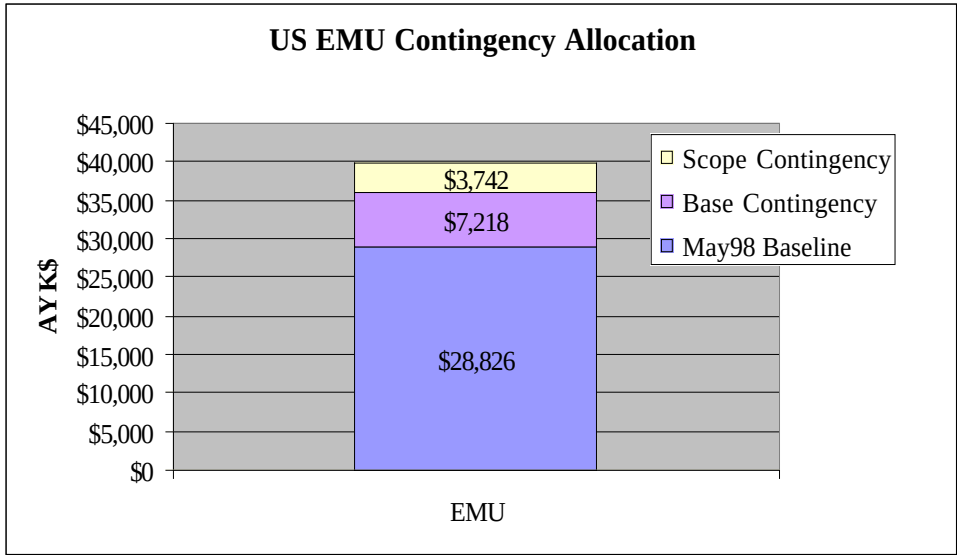
EMU Budget (unescalated)

Wbs #	task	'98-'03 costs	'04-'06 costs
1.1/1.8	cathode strip chambers	16,470	1,122
1.2	electronics	11,954	2,177
1.3	mech. structure	1,283	12
1.4	installation	285	171
1.5	detector controls	189	93
1.6	services	1,113	0
1.7	alignment	903	75
1.9	RPC integration	147	24
1.11	EMU completion tasks	106	0
		32,450	3,674

90% finished

US EMU Status





Work remaining:

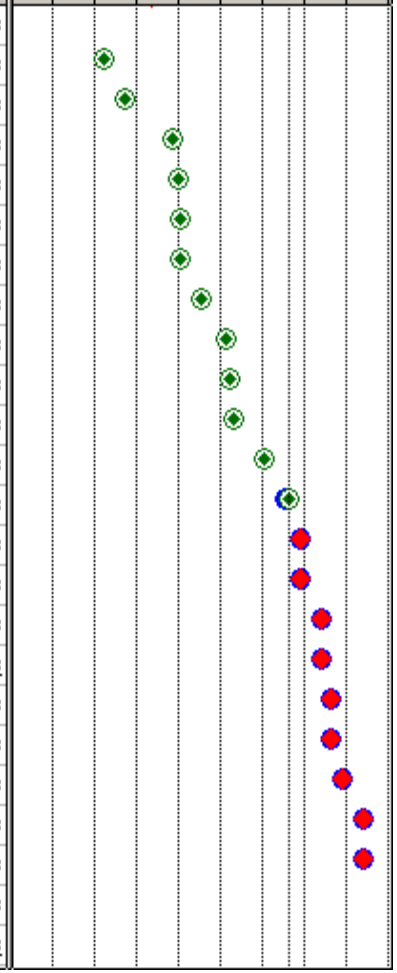
- Installation
- Off-chamber electronics
- Lowering disks

Contingency used for:

- Cost creep (base)
- Move electronics off chambers (base)
- ME1/1 electronics (scope)

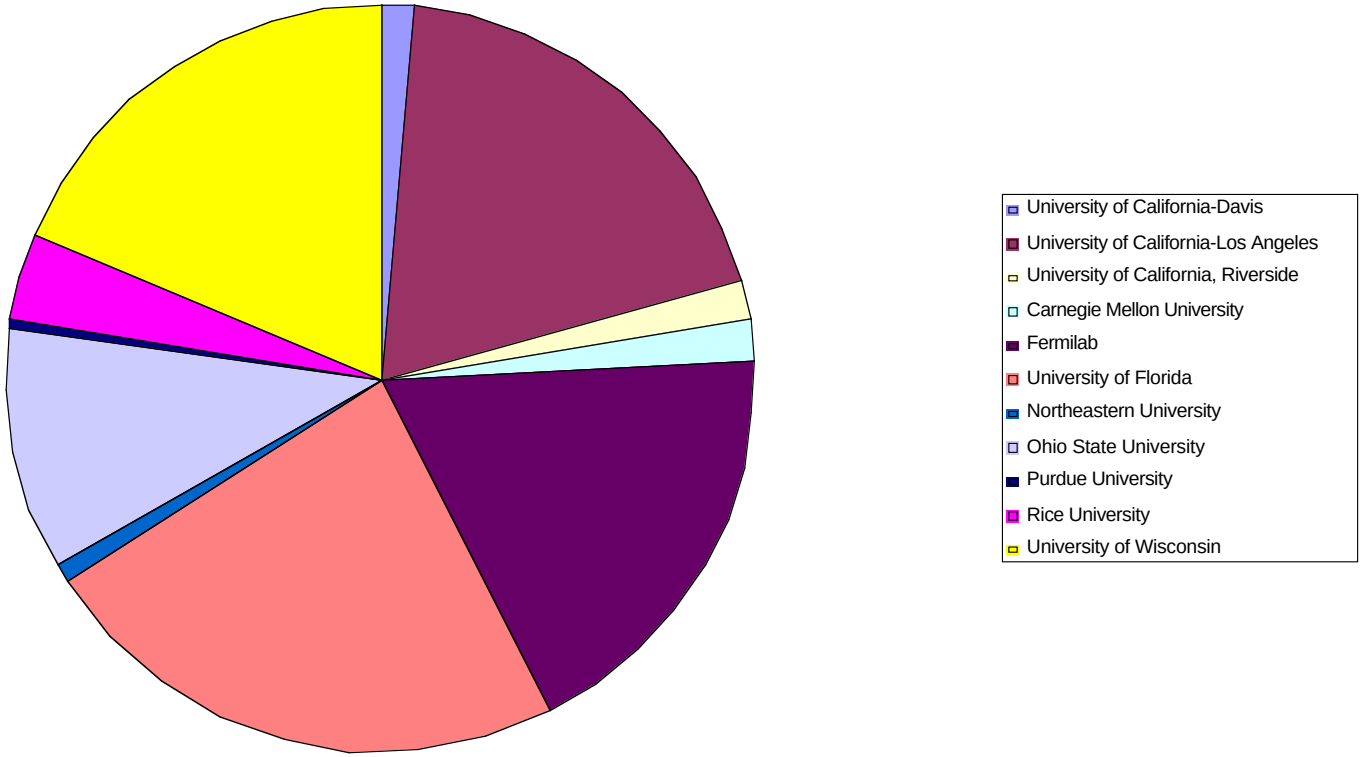
US CMS
EMU Milestones

System	Level?	CMS ID	Milestone	v33	Start	Variance
			Muon System (WBS 1.1)	**NA**	**Dec 2 '98**	**0 days**
MUON	ML2	ME-009	Mechanical Engineering Design Review	Dec 2 '98	Dec 2 '98	0 days
MUON	ML2	ME-010	Begin Mass Production of CSC Parts (panels)	May 31 '99	May 31 '99	0 days
MUON	ML2*	ME-011	Begin Assembly of Cathode Strip Chambers at FNAL	Jul 14 '00	Jul 14 '00	0 days
MUON	ML2	ME-012	Pre-Production ASIC's Ready	Sep 1 '00	Sep 1 '00	0 days
MUON	ML3	ME-053	Delivery of Pre-Production ASICs for Anode Front-End	Sep 30 '00	Sep 30 '00	0 days
MUON	ML3	ME-054	Delivery of Pre-Production ASICs for Cathode Front-End	Sep 30 '00	Sep 30 '00	0 days
MUON	ML2*	ME-013	Begin Mass Production of Electronics Boards	Mar 31 '01	Mar 31 '01	0 days
MUON	ML2	ME-015	Begin CSC Mass Production at PNPI/St. Petersburg	Oct 31 '01	Oct 31 '01	0 days
MUON	ML2*	ME-014	Begin Mounting Electronics and Testing at UCLA/UF	Dec 6 '01	Dec 6 '01	0 days
MUON	ML2	ME-1019	Begin CSC Mass Production at IHEP/Beijing	Dec 30 '01	Dec 30 '01	0 days
MUON	ML3	ME-058	20 ME23/2 CSC's Delivered from UC/UF to CERN	Sep 30 '02	Sep 30 '02	0 days
MUON	ML3*	ME-061	70 ME23/2 CSC's Delivered from UC/UF to CERN	Mar 31 '03	Apr 23 '03	17 days
MUON	ML3	ME-060	All 38 ME2/1 CSC's Delivered from PNPI to CERN	Jul 31 '03	Jul 31 '03	0 days
MUON	ML3	ME-062	100 ME23/2 CSC's Delivered from UC/UF to CERN	Jul 31 '03	Jul 31 '03	0 days
MUON	ML2	ME-1022	All 38 ME2/1 and 38 ME3/1 CSC's Delivered from PNPI to	Jan 31 '04	Jan 31 '04	0 days
MUON	ML2*	ME-017	All 148 ME23/2 CSC's Delivered from UC/UF to CERN	Jan 31 '04	Jan 31 '04	0 days
MUON	ML2	ME-016	ME+2 and ME+3 Stations Installed	Apr 30 '04	Apr 30 '04	0 days
MUON	ML2	ME-1024	ME-2 and ME-3 Stations Installed	Apr 30 '04	Apr 30 '04	0 days
MUON	ML2	ME-1025	ME+1/2 and ME+1/3 Stations Ready for Installation	Jul 31 '04	Jul 31 '04	0 days
MUON	ML2	ME-1027	All 74 ME1/2 and ME1/3 CSC's Delivered from IHEP to CE	Jan 31 '05	Jan 31 '05	0 days
MUON	ML2	ME-1028	ME-1/2 and ME-1/3 Stations Ready for Installation	Jan 31 '05	Jan 31 '05	0 days
MUON	ML1	ME-1030	End UX Inst/Cabling/Test on ME Stations on YE+	Feb 28 '06	Feb 28 '06	0 days
MUON	ML1*	ME-1083	End UX inst/cabling/test of CSC stations on YE-	Jul 31 '06	Jul 31 '06	0 days



US EMU FY03 Planning

EMU SOWs FY03 -- $4.3M AY



Issues for next 6 months

- **CERN 25ns test beam**
  - Verify off-chamber electronics, begin production
- **Installation**
  - Delayed 3 months due to delay in gas piping
  - Begin on 2 June -- try to catch up
- **Cabling**
  - Install “back” chambers and cable
  - Then install “front” chambers and cable
- **Commissioning chambers**
  - Use portable DAQ system to check installed chambers
  - Install and checkout alignment system
- **Select HV system - CAEN or PNPI/Florida design**
  - Review of prototype systems at end of June ‘03

Construction Endgame

Finish construction project

- **Install all items**
- **Cable/connect all items**
- **Complete all documentation**
- **Store and inventory all spares**

Begin research program

- **Commission chambers and DAQ**
  - Test chambers using portable DAQ
  - Slice test (combine chambers and subsystems)
- **Begin commissioning in ‘03**
  - Detailed presentation during breakout session

Summary

- **Chamber & electronic production going well**
  - Fermilab factory finished on schedule
  - Off-chamber electronics production will start following electronics review (Oct ‘03)
- **Gas installation now going OK**
  - Should not cause additional delays
- **Chamber installation starts in early June**
  - ~45 chambers ready to be installed
- **Cabling and commissioning starts by late June**
- **Off-chamber electronics ESR in Oct ‘03**
  - Start production by end of year